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RTO EDUCATIONAL NOTES **EN-AVT-151**

Advances in Laminar Turbulent Transition Modelling

(Les avancées dans la modélisation de la transition laminaire turbulente)

Papers presented during the AVT-151 RTO AVT/VKI Lecture Series
held at the von Karman Institute, Rhode St. Genèse, Belgium, 9 -12 June 2008.

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The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Advances in Laminar-Turbulent Transition Modelling

(RTO-EN-AVT-151)

Executive Summary

Accurate modeling of the laminar-turbulent transition process remains a fundamental issue for the detailed description of the flow around wings, aircraft bodies and control surfaces, as well as for prediction of air vehicles drag, control surfaces effectiveness, and aerodynamic noise generation.

AGARD/FDP Lecture Series have been held at the VKI on flow stability and transition in 1984 and 1993 The purpose of this RTO-AVT/VKI Lecture Series proceedings is to revisit the subject in view of the latest advances made in these last fourteen years and their potential on aircraft design, specially taking into account the increased capabilities in numerical simulations and in nonintrusive optical measurement techniques, allowing detailed use of DNS data or of experimental data to understand more deeply the turbulent transition mechanisms, as a necessary prerequisite for a more accurate modeling.

The covered topics include a broad view of stability theory and different transition phenomena and scenarios. Subjects include receptivity of boundary layer to disturbances, by-pass mechanisms which anticipate transition, growth of 3D instabilities and their breakdown mechanisms, progress in parabolized Navier Stokes methods, and transition prediction and control.

Les avancées dans la modélisation de la transition laminaire turbulente

(RTO-EN-AVT-151)

Synthèse

La modélisation précise des processus de transition laminaire/turbulent reste un problème fondamental pour la description détaillée des écoulements autour des ailes, des fuselages d'avion et des gouvernes, ainsi que pour la prédiction de la traînée aérodynamique des aéronefs, de l'efficacité des gouvernes et de la génération de bruits aérodynamiques.

La série de conférences du FDP/AGARD sur la stabilité des flux et la transition s'est tenue au VKI en 1984 et 1993. Le but de cette série de conférences de RTO-AVT/VKI est de revisiter le sujet compte tenu des avancées récentes réalisées au cours de ces quatorze dernières années et d'évaluer leur potentiel pour ce qui concerne la conception des avions, en prenant particulièrement en compte l'accroissement des capacités en matière de simulation numérique et de techniques optiques de mesure non-intrusives, de l'emploi des données DNS ou des données expérimentales afin de mieux comprendre les mécanismes de transition turbulente comme un préliminaire nécessaire à une modélisation plus précise.

Les sujets couverts comprennent une vue d'ensemble de la théorie de la stabilité et des différents phénomènes et scénarios de transition. Les sujets incluent la perméabilité de la couche limite aux perturbations, les mécanismes de déviation qui précèdent la transition, la croissance des instabilités 3D et leurs mécanismes d'éclatement, les progrès effectués dans les méthodes Navier Stoke parabolisées et la prédiction et le contrôle de la transition.

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Supporting documents are attached to the report as separate files (MS Word, PDF, HTM). Papers presented during the AVT-151 RTO AVT/VKI Lecture Series held at the von Karman Institute, Rhode St. Genèse, Belgium, 09-12 June 2008

14. ABSTRACT

Accurate modeling of the laminar-turbulent transition process remains a fundamental issue for the detailed description of the flow around wings, aircraft bodies and control surfaces, as well as for prediction of air vehicles drag, control surfaces effectiveness, and aerodynamic noise generation.
AGARD/FDP Lecture Series have been held at the VKI on flow stability and transition in 1984 and 1993 The purpose of this RTO-AVT/VKI Lecture Series proceedings is to revisit the subject in view of the latest advances made in these last fourteen years and their potential on aircraft design, specially taking into account the increased capabilities in numerical simulations and in nonintrusive optical measurement techniques, allowing detailed use of DNS data or of experimental data to understand more deeply the turbulent transition mechanisms, as a necessary prerequisite for a more accurate modeling.
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